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Seventeenth day of August 2004

**JULIE BILLINGSLEY
TEAM LEADER EXAMINATION
SUPPORT AND SALES**



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CLIPSAL INTEGRATED SYSTEMS PTY LTD

**AUSTRALIA
PATENTS ACT 1990**

PROVISIONAL SPECIFICATION FOR THE INVENTION ENTITLED:

**"RADIO NETWORK COMMUNICATION SYSTEM AND PROTOCOL USING AN
AUTOMATIC REPEATER"**

This invention is described in the following statement:

TECHNICAL FIELD

This invention relates to a network of devices which communicate with each other via radio frequency.

5 BACKGROUND OF THE INVENTION

A network of devices can be created by arranging a group of devices that communicate with each other via radio frequency (RF) means to transmit data between the devices. Provided that each of the devices is within the range of the maximum communications range of each device, each device can effectively

10 communicate with each other device in the network.

In many such networks, the devices may all be transceivers, ie are each capable of both transmitting and receiving. For the purpose of transferring an item of data, one device acts predominantly as a transmitter while other devices act predominantly as
15 receivers. In this context, transceivers, which act predominantly as transmitters will be referred to as transceiver/transmitters. Those which act predominantly as receivers will be referred to as transceiver/receivers.

The present invention is to be used in a "point to multipoint" system as opposed to a
20 "point to point" system in which communications occur between only two devices at a time. In a point to multipoint communication system, communications occur between one device and two or more of the other devices in the network simultaneously.

25 A reliable "point to multipoint" communication system allows the creation of a shared network variable. This is a variable which is known to all of the devices in the network. For example, if one device wants to change the value of the shared network variable, it must transmit a request and be guaranteed that all devices receive and process the updated variable simultaneously. If the update cannot be
30 made simultaneously, or not all other devices in the network receive the update, then the network does not have a shared network variable.

Shared network variables allow the creation of a network which has no central controller. All of the essential data about the operation and control of the network is known by each device in the network simultaneously. The data can be updated by any device in the network at any time and all other devices are guaranteed to update 5 their data accordingly. This allows the control of devices within the network to be simplified, more flexible, and less costly when compared with networks having a central controller.

A single communication action between each of the devices is herein referred to as a 10 Transaction. A Transaction occurs between a device (transceiver/transmitter) which transmits data to one or more transceiver/receivers of the data. The Transaction also includes data sent from the transceiver/receivers to the transceiver/transmitter as well as to each other of the transceiver/receiver devices in the network. This data return is generally an acknowledgement, indicating the success or failure of the 15 receipt of the data sent by the transceiver/transmitter.

When transmitting to more than one transceiver/receiver simultaneously (also known as a broadcast or multicast), it is essential to know that all transceiver/receivers have successfully received the data. If even one 20 transceiver/receiver has not successfully received the data (for example because of a bit error causing data corruption in one transceiver/receiver), then all other transceiver/receivers must be informed that not all of the other transceiver/receivers have successfully received the data. Each transceiver/receiver device must then discard the data it just received. This ensures that data used to update a shared 25 network variable is received either by all transceiver/receivers, or by none of them.

Such networks may use a transmission system with dominant and inferior bits. This means that if there is a conflict, and two devices simultaneously transmit a dominant and inferior bit, then when monitoring the communication medium, each device will 30 see the transmission of the dominant bit. The device transmitting the inferior bit knows that there has been a conflict and can take whatever action is appropriate. For example, this may mean the cessation of all further transmissions.

- In conventional point to point communication protocols, a general procedure is to have each device transmit an acknowledge statement some time after receipt of the data. This has the drawback that the transmitting device must know exactly the
- 5 number of receiving devices within the network, and how to contact each of them. The reliable transfer of the same piece of data to multiple receiving devices requires many transmissions of the same data, and a corresponding wait for each transmission to be acknowledged. The repetitive transmission of the same data to many recipients wastes the available bandwidth of the communication medium. This
- 10 approach also requires the transmitter to obtain and store data about exactly which receiving devices are to accept a given transmission. This approach allows the creation of a shared network variable, at the expense of unnecessary complexity and poor use of the available bandwidth of the communication medium.
- 15 Alternatively a point to multipoint transmission can be used to transfer data to many recipients simultaneously, without any acknowledgment being returned. This renders the data transfer unreliable, and the transmitter will not be able to determine whether all of the receiving devices have successfully received the data. Unreliable transfer of data means that a shared network variable cannot be created.
- 20 The situation is compounded when two or more devices are out of communications range of each other. As it will be appreciated, each device has a maximum transmitting range (determined by design factors, including but not limited to transmit power, receiver sensitivity, antenna type, and signal processing algorithms).
- 25 Communications, and synchronising communications is made more complicated when some devices are outside the maximum range and therefore cannot communicate with each other.
- It is an object of the present invention to provide a system and protocol for
- 30 improving the communications between devices in an RF multicast communications system, using a dominant bit protocol, and particularly between devices which are

disposed beyond the normal communications range of one or more of the other devices in the system.

SUMMARY OF THE INVENTION

- 5 According to a first aspect of the present invention, there is provided a communications protocol for use in a network of devices, the protocol having a frame including a first time slot for transmitting data, a second time slot, after said first time slot, for indicating a repeat flag, and a third time slot, after said second time slot, for retransmitting the data transmitted in the first time slot.
10 Preferably, a fourth time slot, after the third time slot, is provided for allowing acknowledgment of a successful or unsuccessful receipt of the data by devices intended to receive the data.
- 15 Preferably, the fourth time slot is divided into two sub-timeslots. One sub-time slot is for indicating a positive acknowledgment, and the other sub-time slot is for indicating a negative acknowledge.
20 Preferably, the first sub-time slot is the positive acknowledge, and the second sub-time slot is the negative acknowledge.
25 Preferably, the first and third time slots are variable in length and the first and second sub-time slots are fixed in length. Preferably, the positive acknowledge transmission includes the transmission of a specific coded value containing sufficient redundancy to allow it to be recovered in the presence of received errors. Similarly the negative acknowledge transmission includes the transmission of a specific coded value containing sufficient redundancy to allow it to be recovered in the presence of received errors.
30 According to a second aspect of the present invention, there is provided a radio communication system including a first transceiver, a second transceiver and a repeater, the said first and second transceivers being separated from each other by a

distance greater than at least one of their respective maximum transmission ranges, and the repeater being located intermediate the first and second transceivers, wherein upon receiving data from one of either the first or second transceivers, in a first time slot, the repeater transmits a repeater flag in a second time slot, and then in 5 a third time slot transmits the data received in the first time slot.

Preferably, the first and second transceivers transmit, in a fourth time slot, an acknowledgment indicating the successful or unsuccessful receipt of the data transmitted in the third time slot.

10

Preferably, the first and second transceivers transmit a positive acknowledge in a first of two sub-time slots of the fourth time slot or transmit a negative acknowledge in a second of two sub-time slots of the fourth time slot.

Preferably, in a fifth time slot, the repeater will transmit to all transceivers an overall 15 status for the repeated Transaction.

According to a third aspect of the present invention, there is provided a repeater for use in a radio communication system including at least two transceivers, the at least two transceivers being separated from each other by a distance greater than at least one of their respective transmitting ranges, in use, the repeater being disposed

20 intermediate the at least two transceivers wherein upon receiving data in a first time slot, the repeater transmits a repeat flag in a second time slot, and then transmits in a third time slot, the data received in the first time slot.

According to a fourth aspect of the present invention, there is provided a transceiver 25 for use in a radio communication system including at least one other transceiver and a repeater, the transceiver and the at least one other transceiver being separated from each other by a distance greater than at least one of their respective transmitting ranges, in use, the repeater being disposed intermediate the transceiver and the at least one other transceiver, wherein upon receiving a repeat flag from the repeater, in

30 a second time slot, the transceiver suspends further action until it receives from the repeater, in a third time slot, data that was originally transmitted by the at least one other transceiver in a first time slot, before the second time slot.

Preferably, in a fourth time slot, the transceiver will transmit an acknowledgment indicating the successful or unsuccessful receipt of the data transmitted in the third time slot.

5

Preferably, the transceiver will transmit a positive acknowledge in a first of two sub-time slots of the fourth time slot, or transmit a negative acknowledge in a second of two sub-time slots of the fourth time slot.

- 10 Preferably in a fifth time slot, the repeater will transmit to all transceivers an overall status for the repeated Transaction.

According to a fifth aspect of the present invention, there is provided a radio communication system including at least a first transceiver, a second transceiver and
15 a repeater, said first transceiver and said second transceiver being separated by a distance greater than a maximum transmission range of at least one of the transceivers, and said repeater being disposed intermediate the first and second transceivers, such that upon receipt of a data transmission from the first transceiver, said repeater re-transmits the data transmission from the first transceiver, wherein,
20 upon receipt of a data transmission from the second transceiver before the repeater retransmits the data transmission from the first transceiver, the repeater transmits a data sequence instructing each transceiver to cease its respective transmission.

- 25 Preferably, the respective transmissions of the first and second transceivers are headed by a sequence of consecutive dominant bits.

Preferably, the data sequence transmitted by the repeater begins with a sequence of dominant bits.

- 30 Preferably, upon receiving the data sequence from the repeater, causing each transceiver to cease transmitting, each transceiver will delay for a period before attempting to repeat its original transmission.

Preferably, the delay period is calculated by each transceiver selecting a random number and scaling this according to the number of bits in its respective transmission.

5

Preferably, if subsequent transmission retries still collide, subsequently calculated delay periods are increased.

Preferably, after some predetermined number of unsuccessful retries, the radio
10 communication system ceases further transmission attempts and optionally alerts an operator to the communication difficulties.

According to a sixth aspect of the present invention, there is provided a repeater for use in a radio communications system including at least a first transceiver and a
15 second transceiver, the first transceiver and the second transceiver being separated by a distance greater than a maximum transmission range of at least one of the transceivers, in use, the repeater being disposed intermediate the first and second transceivers such that upon receipt of a data transmission from the first transceiver, said repeater retransmits the data transmission from the first transceiver, wherein
20 upon receipt of a data transmission from the second transceiver before the repeater retransmits the data transmission from the first transceiver, the repeater transmits a data sequence instructing each transceiver to cease its respective transmission.

Preferably, the data sequence transmitted by the repeater is a sequence of dominant
25 bits.

According to a seventh aspect of the present invention, there is provided a transceiver for use in a radio communication system including at least one other transceiver and a repeater. In use, the transceiver and the at least one other
30 transceiver are separated by a distance greater than a maximum transmission range of at least one of the transceivers, and the said repeater being disposed intermediate the transceiver and the at least one other transceiver, such that upon receipt of a data

transmission from the at least one other transceiver, the repeater retransmits the data transmission from the at least one other transmitter and upon receipt of a data transmission from the transceiver before retransmitting the data transmission from the at least one other transceiver, the reporter transmits a data sequence instructing 5 each transceiver to cease respective transmissions, wherein, upon receipt of the data sequence from the repeater, the transceiver will cease transmission.

Preferably, the transmission from the transceiver will be headed by a sequence of consecutive dominant bits.

10

Preferably, upon receiving of the data sequence from the repeater, the transceiver will delay for a period before attempting to repeat its original transmission.

15

Preferably, the delay period is calculated by the transceiver selecting a random number and scaling this according to the number of bits in its transmission.

20

Preferably, if subsequent retransmissions still result in receipt of a data sequence from the repeater, the transceiver will increase its subsequently calculated delay periods. Preferably, after some predetermined number of unsuccessful retrasmssions, the transceiver will cease further transmission attempts and optionally alert an operator to the communication difficulties.

The system and protocol of the present invention have many uses including applications in controlling domestic, industrial and office appliances.

25

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows one network architecture according to a preferred embodiment of the present invention;

30

Figure 2 shows the network protocol model used in the environment of the present invention;

Figure 3 shows a frame structure according to a preferred embodiment of the present invention;

Figure 4 shows a repeater and two transceivers disposed in a network according to the present invention; and

Figure 5 shows a frame structure used in the configuration of Figure 4.

5 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An exemplary architecture of a network is shown in Figure 1, in which the network 10 is made up from nodes 1, 2 and 3. Nodes 1, 2 and 3 are transceiving devices and may act as transmitters and/or receivers in a given communication Transaction. The network 10 may communicate with other networks 20, via gateway 11.

10

The protocol design of the present invention is based on the ISO seven layer model and some terminology is common with that used by ISO. The protocol used in the present invention is connectionless, meaning that once a single data transfer has taken place, there is no expectation of additional related data transfers either before or after.

15

The protocol model of the present invention is based on the ISO seven layer model and is shown in Figure 2. For applications distributed over two nodes, each protocol layer has a virtual connection to the equivalent layer in the other node. As can be seen, each layer takes data provided by the layer above, treats it as a data unit and adds its own protocol control information (PCI) field. At each layer, the protocol data unit (PDU) is either the data, or a package provided by the next higher layer. The name of the PDU is prefixed by the layer to which it applies (For example, SPDU is a session PDU).

20

The physical layer relates to the mechanical and electrical network interface in the ISO system. In the system of the present invention, the physical layer refers to the hardware and firmware elements used to transmit and receive bits over the communication medium.

25

In the ISO system, the link layer is used for data link control (for example, framing, data transparency, error control). In the present invention, the link layer is used to

break bytes up into bits, bit stuffing (if required), framing, collision detection, prioritisation, error detection, positive/negative acknowledge generation, checking and retransmission.

- 5 The network layer in the ISO system is used for networking routing, addressing, call set-up and clearing while in the present invention, the network layer is used for network routing, addressing, Transaction set-up and clear.

- In the ISO system, the transport layer is used for end to end message transfer,
10 connection management, error control, fragmentation and flow control. The transport layer is not used in the environment of the present invention.

The session layer in the ISO system is used for dialogue and synchronisation control for application entities but is not used in the environment of the present invention.

15

The presentation layer is used for transfer syntax negotiation, and data representation transformations in the ISO system while in the environment of the present invention, the presentation layer is used for optional encryption of application data.

20

The application layer in the ISO system is used for file transfer, access management, document and message interchange, job transfer and manipulation while in the environment of the present invention, the application layer supports sending and receiving application data.

25

Finally, the user application layer is used both in the ISO and the environment of the present invention for whatever is needed to achieve a specified function or behaviour.

- 30 It is predominantly in the link layer that the features of the present invention reside.

In the protocol of the present invention, use can optionally be made of a dominant bit, and an inferior bit. If two devices simultaneously transmit a dominant and an inferior bit, then receivers and transmitters (monitoring their own transmissions) will detect only the dominant bit.

5

- Media access is obtained by a transmitter first monitoring the media, and if no existing transmission is detected, the transmitter will try to claim media access by transmitting a preamble stream. This preamble starts with at least one detectable bit. The claim for media access defines the start of a Transaction. A Transaction consists
10 of all data transfer, acknowledgement and repeating of data. All nodes in a network must monitor the media continually and if they detect a Transaction occurring they will defer any attempt to claim media access until the completion of the current Transaction.

15 Transactions are asynchronous: they can occur at any time and the time difference from the start of one Transaction to the next does not have to be an integral number of bit periods.

- In this application, a Transaction is specifically defined as a continuous period of
20 time broken up into several sub-time slots containing different types of data. A Transaction will begin with a preamble for a set period of time, followed by the specific data which is to be transmitted from a transceiver/transmitter to two or more transceiver/receivers. The timeslot during which the data is transmitted is variable in length, and includes a portion used as a frame check sequence. Following
25 the data transmission is a timeslot during which positive acknowledgement can be transmitted by the transceiver/receivers, followed by a timeslot during which negative acknowledgement is transmitted by the transceiver/receivers. The structure of this frame is shown in Figure 3.

30 As described above, a Transaction is asynchronous and can start at any time. However, once started, the Transaction has a time-based structure. Special markers in the Transaction are used to show the beginning and end of the data portion. The

time slots during which the positive and negative acknowledgement are transmitted, are fixed in time. By careful coding and redundancy of data encoded into these timeslots, a positive acknowledgement by one or more transceiver/receivers and a negative acknowledgement by one or more transceiver/receivers can be conveyed.

- 5 All of the devices involved in the Transaction see both of the acknowledgment timeslots.

Transceiver/receivers wishing to positively acknowledge, will transmit a special code during the positive acknowledge timeslot and during the negative acknowledge

- 10 timeslot will either receive (if dominant bit transmission is not used) or transmit inferior bits (if dominant / inferior bits are used).

Similarly, transceiver/receivers wishing to negatively acknowledge will either transmit inferior bits (if dominant / inferior bits are used) or receive (if dominant bit

- 15 transmission is not used) during the positive acknowledge timeslot and transmit a special code during the negative acknowledge timeslot.

The fact that the devices monitor the timeslots they are not transmitting, ensures that by the end of two acknowledge timeslots each device has detected either positive

- 20 acknowledges, negative acknowledges or both and can therefore work-out the overall acknowledge state of the network.

For example, the transceiver/receiver which transmits a positive acknowledge will be able to detect some other transceiver/receiver which transmits a negative

- 25 acknowledge. For the case where dominant bits are used, this is because the transceiver/receiver positive acknowledging will attempt to transmit inferior bits during the negative acknowledge timeslot but will detect dominant bits due to the other transceiver/receiver which is simultaneously transmitting an appropriate code during the negative acknowledge timeslot. For the case where dominant bits are not used, the transceiver/receiver positive acknowledging will receive during the negative acknowledge timeslot and detect any bits due to the other transceiver/receiver which is transmitting an appropriate code during the negative

acknowledge timeslot. The reverse case applies for the transceiver/receiver transmitting a negative acknowledge.

At the end of the Transaction, all devices do not know how many positive or

- 5 negative acknowledges there were, all they have to know is that there were some positive and some negative.

If there were any negative acknowledges at all during the Transaction, then all of the transceiver/receivers know this, and can discard the data received. Similarly, the

- 10 transceiver/transmitter knows this and can attempt to re-run the Transaction.

The generation of a positive acknowledge will be as follows. Upon receiving data, a node will generate a positive acknowledge only when:

- the data timeslot has been checked against its embedded frame check sequence and found to be valid; and
-any addressing information present in the data timeslot matches an addressing information used by the device.

Each device transceiver generally contains at least two different types of address, as follows:

- 20 - A Unit Address, allowing the device to be uniquely addressed in isolation; and
- A Multicast address, allowing those devices in a network to be addressed simultaneously for the purpose of updating shared network variables.

In addition, devices can also optionally contain:

- 25 - A Network Address, allowing physical devices to be grouped by the logical network to which they are allocated.

Other variations are possible, but these three address types are fundamental, and used as the basis for other more sophisticated addressing schemes.

- 30 The processes involved in generation of a negative acknowledge are as follows. A receiving device (transceiver/receiver) will generate a negative acknowledge only if

the data timeslot is determined to be corrupted, by checking the received data using the embedded frame check sequence.

- Where a device determines data timeslot corruption, there is no point further
- 5 examining any fields inside the data timeslot.

Acceptance of the data transmitted by the transceiver/transmitter is only made by the transceiver/receivers if the condition for generation of a positive acknowledge are met and if no other transceiver/receiver has generated a negative acknowledge.

- 10 This ensures that all transceiver/receivers receive a given message only once. For point-multipoint messages, this may mean that a message is discarded by a transceiver/receiver, even if it appears valid and was positively acknowledged.

The above describes the general environment in which the present invention can be

- 15 utilised. The sequences described above can only be used when each device is within range of the other. It will be understood that each device will have a maximum transmitting range, beyond which it cannot communicate with other devices. The maximum transmitting range is determined by design factors, including but not limited to transmit power, receiver sensitivity, antenna type, and signal processing

- 20 algorithms. For short range (unlicensed) devices, the range is typically from tens to, at most, several hundred metres. In the case where one or more devices are located beyond the maximum transmitting range of another device (ie cannot communicate with that device directly), difficulties in implementing the above-described procedure will be encountered. Particularly, in the case where a

- 25 transceiver/transmitter transmits data , some or all of the other transceivers/receivers will not receive the data from that particular transceiver/transmitter and accordingly, will make it impossible to update shared network variables.

- 30 In accordance with the present invention, the protocol described above is modified to allow the retransmission of data between devices so as to extend the effective transmission range of the devices used in the network. The modified protocol is

used in conjunction with a repeater which is placed roughly in the geometric centre of devices in the network and acts as a relay between devices distributed beyond their normal transmission range.

- 5 Figure 4 shows an example configuration of devices A and B in a network. Devices A and B are separated by a distance greater than each of their respective transmitting ranges. Thus, if device A were to transmit data as described above, device B would not receive this data and would not know how to proceed as described above. In accordance with the present invention however, repeat device 10 is placed between
- 10 devices A and B and acts as a repeater. Thus, if device A transmits data, repeat device 10 will receive this transmission from device A and retransmit the data such that device B will receive device A's data. When device B transmits its acknowledgment, this will be received by the repeater. The repeater in turn transmits an overall acknowledge status which will be received by both devices A and B. Both
- 15 devices then know that the information was relayed by the repeater, and in turn accepted or rejected by all devices in range of the repeater. Devices A and B can then proceed in the normal manner.

- 20 Of course, device B for example need not be a transceiver/receiver but may be a transceiver/transmitter. In this case, device B will transmit information to the network however, because device A (for example a transceiver/receiver) being out of range of device B would not receive the transmitted data. Again, repeat device 10, being disposed between device A and device B, will receive the data transmitted by device B, and retransmit this data so that device A and any other devices within the
- 25 range of repeat device 10 will receive the retransmission. Similarly, the acknowledgment from device A will be received by the repeater, which in turn provides an overall acknowledge status back to device B.

- 30 It will be appreciated that in practice, repeat device 10 does not need to be placed directly between two devices but may be placed in any suitable position such that devices within the network can be reached.

- In some cases, it may be possible that device A will have sufficient range to reach device B however, device B, having a shorter transmission range than device A, will not be able to communicate with device A. In this case, repeat device 10 may be positioned closer to device B than to device A in order to allow transmissions from
- 5 device B to reach repeat device 10 which can then be repeated and communicated to device A.

- Practically, it is beneficial to construct all devices in the network in the same way. This means that each device, whether it acts as a transceiver/transmitter,
- 10 transceiver/receiver or repeat device, will be constructed in the same way and can be separately enabled to perform their desired functions. This provides significant savings in the complexity and cost of manufacture since only one device need be manufactured.
- 15 In use, if a device has been set as a repeater, upon receiving information in the first frame (see Figure 3), the repeater will immediately transmit a repeat flag in a new second time slot and then retransmit, in a new third time slot, the data received in the first time slot. The network then operates normally as described above in that devices being transceivers/receivers that have received the retransmitted
- 20 information will then proceed to acknowledge the successful or unsuccessful receipt of that data as discussed above, and the repeater will issue a final overall repeat status to inform all devices in the network of the success or failure of the repeated data.
- 25 The modified protocol frame is shown in Figure 5. A comparison with the frame of Figure 3 clearly shows the differences between the modified repeat tag transaction of Figure 5 and the non-repeat tag transaction of Figure 3. Specifically, the first time slot providing for transmission of data is present in both transaction frames however, in the repeat tag frame of Figure 5, a second time slot is provided for the
- 30 transmission of a repeat tag flag. A third time slot is provided in which the data transmitted in the first time slot is then retransmitted. The frame structure then continues in the repeat tag frame structure of Figure 5 in the same way as the non-

repeat tag frame structure of Figure 3. Specifically, an acknowledgment time slot is provided containing a first sub-time slot for transmitting a positive acknowledge and a second sub-time slot for transmitting a negative acknowledge. Furthermore, in the repeat tag frame of Figure 5, an additional time frame is provided for the

5 transmission of a repeat status which provides confirmation to all devices that the transmission has been repeated.

The situation described above in relation to the repeater is complicated even further by the fact that it is possible that some devices will begin the transmission at the

10 same time. When all devices are within range of each other, collisions can normally be dealt with easily when a system of dominant and inferior bits is used. Firstly, collisions are avoided by monitoring the transmission medium before transmitting. This leaves a small period during which simultaneous transmission can begin. In the event that two devices simultaneously begin transmission in this small period, there

15 will inevitably be a difference in the data bits being transmitted. When this difference occurs, the device that transmits the inferior bit will detect a dominant bit due to the other transmitter, and can then cease further transmission.

The device that detects the collision reschedules its transmission for some later time. This time delay can be based on a small random number, scaled by the length of the

20 message to be transmitted.

In the case where a repeat device is used, there is a much longer delay between a device transmitting and another device receiving that transmission via the repeater.

25 For example, with reference to Figure 4, if device A begins transmitting, there will be a delay between the time repeat device 10 receives device A's transmission and the time it retransmits the transmission to be received by device B. During this time, device B may begin transmitting its own data. This new transmission will cause a collision, which is detectable at the repeater but not at device A. This situation is

30 addressed by another aspect of the present invention.

Specifically repeat device 10 checks the data that it receives. If it detects a bit stuffing violation or a data coding violation during its reception, this indicates that devices A and B are transmitting simultaneously. Upon detection of this, repeat device 10 deliberately begins transmitting a long stream of dominant bits (for example 6 to 8 bits), which violate the normal bit stuffing or data coding rules. This will cause devices A and B to both detect a collision, and cease transmission according to normal collision detection and resolution rules as described above.

- 5 As for a normal collision, Devices A and B then each schedule a retransmission after
10 a random time delay, scaled according to the message length. The likelihood of this delay being identical for each device is very small however, should each device again begin transmitting at the same time, the delay period is recalculated, but this time, each device multiplies its respective delay period by two. For each subsequent failure, the successive delay periods are doubled up to some predetermined number
15 of doublings. At this point, the transmission will be aborted and optionally the operator can be notified by any suitable means. In most cases however, the random delay period will result in a resolution to the conflicting transmissions and the devices of the network will be able to continue transmitting in the normal manner.
- 20 It will be understood that the above has been described with reference to a preferred embodiment and that many variations and modifications may be made within the scope of the present invention.

25 Dated this 8th day of August, 2003.

Clipsal Integrated Systems Pty Ltd
By its Patent Attorneys
MADDERNS



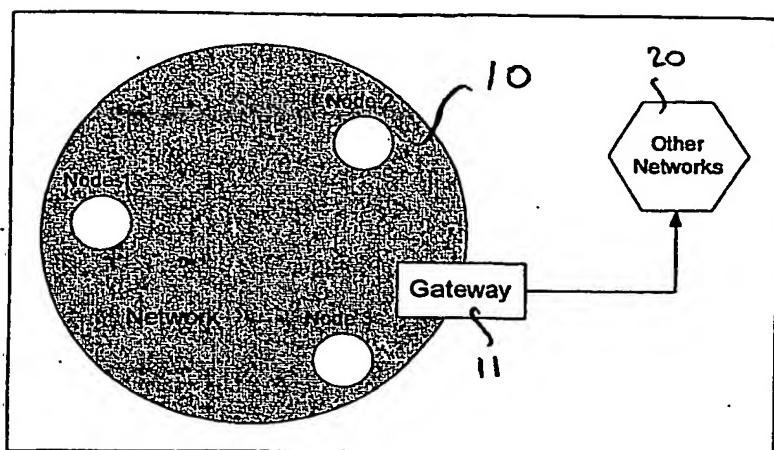


Fig. 1

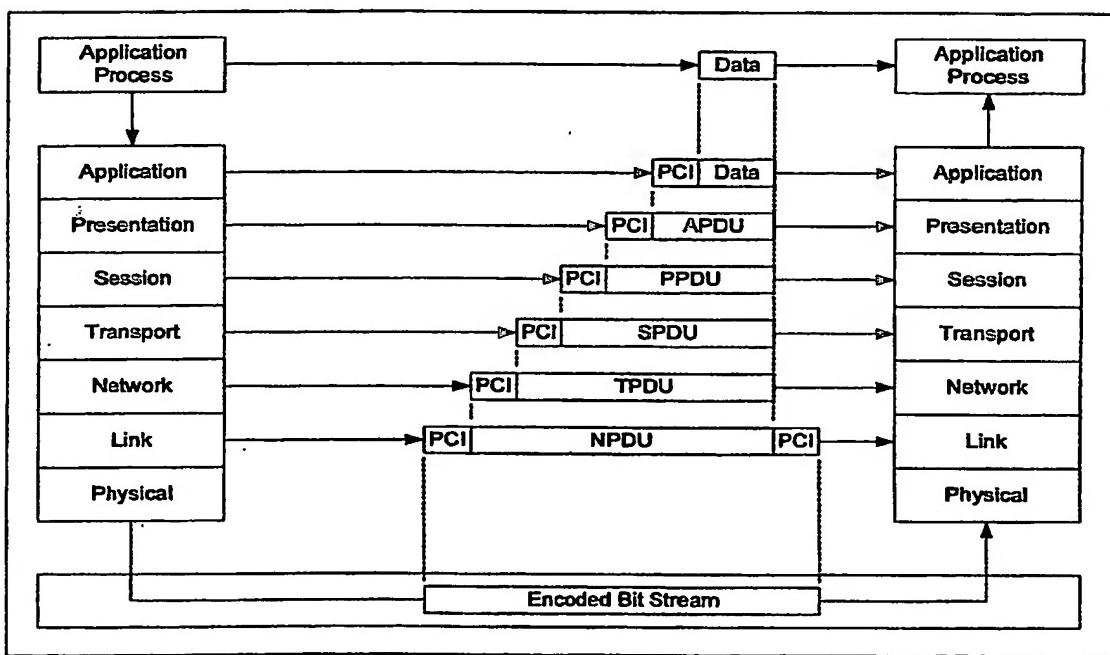


Fig. 2

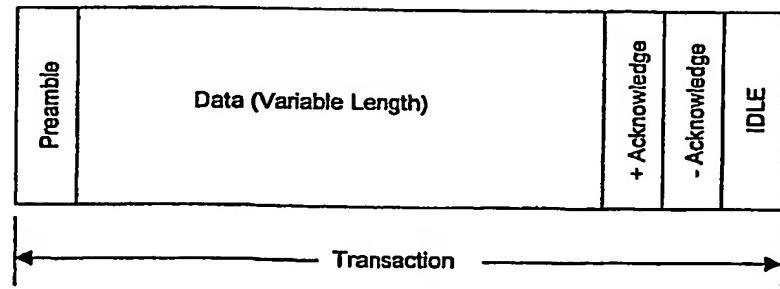


Fig. 3

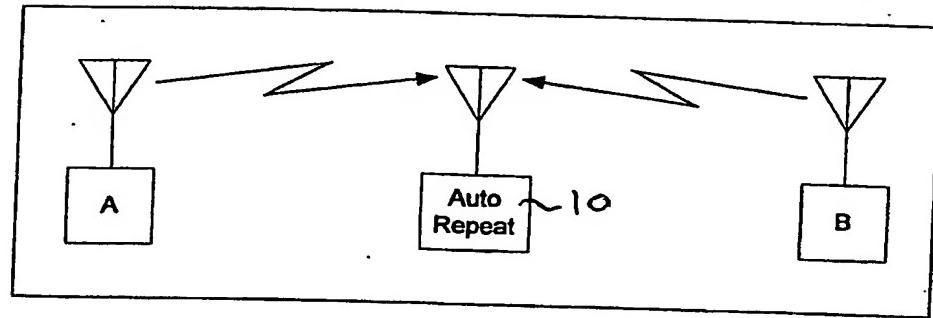


Fig. 4

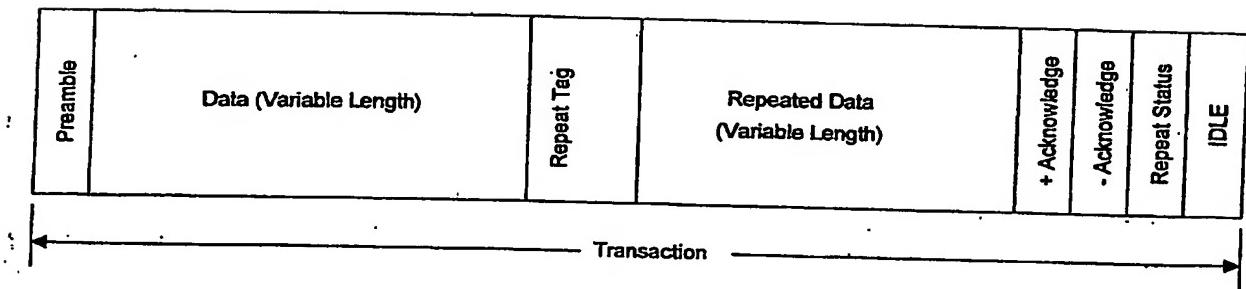


Fig. 5